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SCREENING BREAD WHEAT GENOTYPES FOR DROUGHT TOLERANCE 2- GENETIC PARAMETERS, ASSOCIATIONS AND PATH COEFFICIENT ANALYSIS

[27]

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ABSTRACT

The present investigation was executed at two locations (El-Arish & (Rafah), Suez Canal University during rain-fed growing season (2006 / 2007) on screened ten bread wheat genotypes. Mean squares and some genetic parameters for the investigated characters are discussed. Grain yield was positively and significantly correlated with each of No. of spikes / plant under Arish conditions and 1000 grain weight as well as biological yield at both Arish and Rafah locations? . The main source (direct effects) of plant grain yield variation estimated under Arish conditions is 1000 grain weight followed by number of spikes / plant, number of grains /spike and biological yield. Estimates of characters responsible for variation in order of relative importance were: number of spikes/plant (12.2%), No.of grains/spike (13.3%), 1000 grain weight (50.7%) and biological yield (17.5%) under Arish conditions while it could be arranged in descending order as 1000 grain weight (51.9%), number of grains / spike (45.5%), Number of spikelets / spike (1.4%) at Rafah environment.

INTRODUCTION

Most genetic analyses in wheat concentrate on elucidating the mode of inheritance of characters separately. However, it is equally important to study the genetic relationships between different characters so that the consequences of selection for one character on the performance of another can be predicted. The degree of genetic relationship between pairs of characters is expressed by the genetic covariance or its standardized form, the correlation coefficient. Functionally, a significant relationship implies the pleiotropic effect of the same genes or linkage genes controlling the separate characters.

Many published examples of correlations between characters in wheat have been obtained from studies on samples of varieties. Using path coefficient analysis which is simply a standardized partial regression analysis appears to be helpful in partitioning the correlation coefficients into direct and indirect effects. This information is useful for establishing selection criteria in terms of correlated responses for characters, which can be difficult to measure because of low in heritability or complexity of measurement.

The progress in research for developing wheat genotypes for stress tolerance and good agronomic characters has not been commensurate with the needs because the narrow base of germplasm used and inadequacy of the selection methods to detect genotypes superior under stress environments. Meantime, many reports **[Mitkees *et al* 1992; Deswal *et al* 1997; Uddin *et al* 1997; Afiah,1999; Dencic *et al* 2000; Krishnawat *et al* 2000; Shukla *et al* 2000, Tamman *et al* 2000; Hassan and Afiah, 2002 and Mohamed *et al* 2005]** identified lines with wide adaptation and ability to withstand the aimed environments. They have also used correlation analyses to ascertain relationships between variables and tested various path analyses models to determine the importance of the yield components contributing to grain yield and found that path analysis is useful.

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The aim of the present investigation is to, (1) estimate the amount of variability and predict heritability under the aimed environment (2) study the nature of interrelationships between characters contributing to wheat grain yield (3) partition plant yield variation and (4) detect the relative importance of agronomic characters that could guide the breeder in selection programs.

MATERIALS AND METHODS

The present investigation was executed at the Experimental Farms, Faculty of Agricultural & Environmental Sciences, at two locations (El-Arish & Rafah), Suez Canal University during rain-fed growing season (2006 / 2007). The material used in this study included 9 bread wheat genotypes that showed high drought tolerance in our previously investigation and local check cultivar (Sakha 69) as comparative variety (Abd El-Moneim *et al* 2008). Name/ Cross, pedigree and origin of the 10 bread wheat genotypes tested are illustrated in **Table (1)**.

Two field experiments were conducted in split plots design with four replicates was employed. Irrigation treatments were arranged in main plots and bread wheat genotypes were randomly distributed in sub-blots. Each plot consisted of 5 rows. The row length was 2 m, row to row spacing was 0.2 m and plant to plant distance was about 0.1 m. The recommended cultural practices for wheat production were followed according the local growers in each location, except irrigation. Total rainfed during 2006/ 2007 growing season were 79.95mm. and 123.12mm. at Arish and Rafah locations, respectively. Four irrigation treatments were conducted in the investigated soils as follow:

T1: Rainfall according to ordinary seasons.
T2: irrigation at 50 % of field capacity.
T3: irrigation at 65 % of field capacity
T4: irrigation at 80 % of field capacity.

Statistical parameters

Genotypic coefficient of variation (G.C.V) and phenotypic coefficient of variation (P.C.V.) were accounted, whereas the intra-genotypes variability parameters were calculated according to Singh and Narayanan (2000).

G.C.V. = $\sigma g / x * 100$
P.C.V. = $\sigma ph / x * 100$

Where: σg, σ ph and x are the phenotypic, genotypic standard deviations and genotypes mean, respectively.

Heritability in broad sense (h^2_{bs}) was calculated for all characters recorded using the components of variation as following

$$h^2_{bs} = \sigma^2 g / \sigma^2 ph$$

Where: σ^2 ph and σ^2g are the phenotypic and genotypic variances.

Simple phenotypic correlation coefficient was computed between each pair of traits under severe drought stress treatment (rainfed only) at the two locations according to Singh and Narayanan (2000). The involved characters in this correlations are recorded as mean of 10 plants in each plot:-

(x1) Plant height (cm)
(x2) Peduncle length (cm)
(x3) Spike length (cm)
(x4) No. of spikes / plant
(x5) No. of spikelets / spike
(x6) No. of grains / main spike
(x7) 1000 grain weight (g)
(x8) Grain yield / plant (g)
(x9) Biological yield / plant (g)

RESULTS AND DISCUSSION

The use of selection criteria in wheat breeding program for the economic characters is of great importance for improving wheat yield. Selection criteria are largely conditioned by the values of heritability, genotypic and phenotypic variances, correlation and the relative contribution to yield made by its attributes. Heritability in broad sense estimates the amount of the total genetic variation in relative to the total phenotypic variance. In the meantime, the correlation between characters measures the type and kind of association between these characters. The values of the above mentioned parameters for the economic characters in wheat usually used as indicators for selecting high yielding wheat genotypes.

Variations and genetic parameters

The test of homogeneity of error variance made using error mean squares of the two locations revealed that error mean squares are heterogeneous for all traits studied except No. of spikes/plant, peduncle length and 1000 grain weight. In such case combined analysis over location is expected to be misleading. Therefore, the data of each location analyzed separately. Mean squares and the genetic parameters estimated for the investigated

Table 1. Name/ Cross, pedigree and origin of ten bread wheat genotypes tested

No.	Name/ Cross	Pedigree	Origin
G.1	FOW-2/SD8036	ICW93-0402-1AP-OL-4AP-0L-0AP	Syria
G.2	TRACHA-2//CMH76252/PVN'S'	ICW93-0065-2AP-0L-0BR-0AP	Syria
G.3	NS732/HER//SHUHA	ICW91-0253-0TS-1AP-0TS-0AP	Syria
G.4	LIRA/SHA5	CP02645-11C0OY-030M-7yoghurt-2yoghurt-0M-0AP	Mex/Syr
G.5	PIK/OPATA	CM94950-73yoghurt-0M-0Y-0RES-0AP	Mex/Syr
G.6	NS732/HER//SHUHA'S'	ICW91-0208-2AP-0TS-3AP-0AP	Syria
G.7	W3918A/JUP/NS732/HER	ICW91-0084-6AP-0TS-4AP-0L-0AP	Syria
G.8	TEVEE'S'/KAUZ'S'	ICW91-0235-2AP-0TS-1AP-1AP-0L-0AP	Syria
G.9	FOW-2/SD8036	ICW93-0402-1AP-OL-3AP-0L-0AP	Syria
G.10	Sakha 69 (check variety)	Inia/PL-4220117C/YR"S"Cn-15430-25-5-1980	Egypt

characters are given in **Table (2)**. The results showed that mean squares of the main source of variation, i.e. irrigation treatments and genotypes were highly significant for all traits studied in both locations suggesting that all traits were markedly affected by soil moisture deficit with presence of wide range of differences between genotypes tested. However, the interaction between genotypes and irrigation treatments was also highly significant for all cases, except spike length, No. of spikelets/spike at Rafah location and for peduncle length, No. of grains/spike, 1000-grain weight, grain yield/plant under Arish location. These results are in harmony with those earlier obtained by **Afiah *et al* (2000), Afiah and Moselhy (2001) and El-Shouny *et al* (2005).**

Values of phenotypic (PCV) and genotypic (GCV%) coefficients of variation and heritability in broad sense (h^2_{bs}) under Arish and Rafah conditions for all traits recorded are shown in **Table (2)**. All traits showed little discrepancy between percentages of PCV and GCV except No. of spikes/ plant in the two locations and biological yield at Arish location,. indicating a small effect of environmental factors on most characters, while, the two exceptional characters are greatly influnced by the changes in environmental conditions. This confirmed by the small percentages of broad sense heritability for the above exceptional traits. These results are in line with those reported by **Abdel–Moneim (1993), Afiah and Moselhy (2001)** and **Hassan and Afiah (2002).**

Correlation between characters

With respect to values of correlation coefficients between grain yield per plant and each trait and between other pairs of agronomic characters under Arish and Rafah environments **(Table, 3)**, the obtained results revealed that grain yield was positively and significantly correlated with each of No. of spikes / plant under Arish conditions and 1000 grain weight as well as biological yield at both Arish and Rafah locations.

The correlation among yield contributors showed positive and significant associations between No. of spikes/plant and 1000 grain weight under Arish conditions, and between No. of spikelets/spike and each of plant height, peduncle length and spike length under both environments.

In this respect, previous studies **(Mitkees *et al* 1992; Chaturved and Sharma *et al* 1995; Deswal *et al* 1996; Uddin *et al* 1997 and Tammam *et al* 2000)** also reported that grain yield was positively and significantly associated with each of spikes / plant, kernels / spike, 1000-kernel weight and spike length in bread wheat under varying environments.

Path-coefficient analysis

Estimates of direct and indirect path coefficient effects as well as components of yield per plant variations under Arish and Rafah environments were estimated. The correlation

Table 2. Mean squares and genetic parameters of all traits recorded at Arish and Rafah locations

Sources of variations	df	Plant height	No. of spikes /plant	Peduncle length	Spike length	No. of spikelets /spike	No. of grains /spike	1000 grain weight	Grain yield /plant	Biological yield /plant
Analysis of variance under Arish environment										
Rep	3	10.49	0.05	81.96	0.41	1.50	3.49	0.72	1.34	10.92
Irrig. (A)	3	289.8**	269.2**	229.2**	257.8**	162.5**	328.4**	342.5**	200.7**	1498.2**
Error (a)	9	12.18	0.03	22.41	2.00	0.68	1.56	0.80	0.33	9.58
Lines (B)	9	2221.3**	0.44**	365.48**	13.26**	186.42**	34.65**	30.2**	2.74**	25.25**
AB	27	2.63	0.07	19.04**	0.16	1.29	6.05**	5.32**	0.27**	4.17
Error (b)	108	19.15	0.07	8.86	0.82	2.19	1.97	0.42	0.12	5.13
Analysis of variance under Rafah environment										
Rep	3	16.06	0.04	71.29	2.85	0.68	2.27	1.86	0.39	1.51
Irrig. (A)	3	390**	299.1**	246.7**	162.5**	193.3**	315.1**	162.5**	156.8**	930.7**
Error (a)	9	7.10	0.04	25.97	1.80	0.95	1.56	0.42	0.07	3.72
Lines (B)	9	1678**	1.16**	374.6**	13.42**	182.6**	53.18**	29.09**	17.68**	129.22**
AB	27	168.6**	0.54**	19.84**	0.38	1.33	6.71**	5.82**	0.65**	7.42**
Error (b)	108	23.40	0.07	8.86	0.86	2.05	2.74	0.42	0.27	3.90
Genetic parameters under Arish environment										
GCV%	-	17.60	2.27	17.07	8.61	18.66	4.05	3.79	7.21	6.84
PCV%	-	18.52	4.63	21.07	11.54	20.18	6.62	5.64	10.29	14.85
h^2%	-	90.23	24.01	65.65	55.62	85.47	37.41	45.14	49.10	21.21
Genetic parameters under Rafah environment										
GCV%	-	13.97	2.40	15.33	7.39	16.71	4.91	3.56	12.92	13.53
PCV%	-	17.85	5.81	18.92	10.20	18.08	7.42	5.30	14.97	17.26
h^2%	-	61.24	17.08	61.53	52.42	80.76	43.76	48.21	74.51	61.41

**: Denote significant at 0.01 probability level.

coefficients recorded in **Table (3)** were used in the path coefficient analysis to detect the relative importance of each character to grain yield variation. The components of the total grain yield/plant variation determined directly and jointly by each trait under Arish and Rafah are presented in **Tables (4 and 5)**. Under Arish conditions the main sources of plant yield variation in order of importance were the direct effect of 1000-grain weight (29.52%) and its joint effects with number of spikes/plant (14.39%), biological yield /plant (14.39%) and number of grains/main spike (13.65%) followed by direct effect of biological yield/plant (7.75%), number of grains/main spike (4.43%) and joint effect of number of grains/plant *via* biological yield/plant (3.69%), number of grains/main spike (2.58%), direct effect of number of spikes/plant (1.85%) and joint effect of number of grains/main spike through biological yield/plant (1.48%). The total contribution of the four traits was 93.73%, while the residual effect assumed to be about 6.27% of the total phenotypic variation. The data show that the total contribution of the four characters directly or jointly on grain yield were lower than that under Rafah environment **(Table 5)**. The sources of grain yield variation considered herein were responsible for 99.2% and 93.8% under Arish and Rafah locations, respectively.

Table 3. Simple correlation coefficients among all possible pairs of characters studied under Arish and Rafah conditions

Characters		Plant height (x1)	X2	X3	X4	X5	X6	X7	X8
Peduncle length (x2)	Arish	.974**							
	Rafah	.846**							
Spike length (x3)	Arish	.904**	.941**						
	Rafah	.730**	.915**						
No of spikes / plant (x4)	Arish	-.289	-.252	-.264					
	Rafah	.191	.320	.508					
No of spikelets /spike (x5)	Arish	.786**	.806**	.763**	.006				
	Rafah	.881**	.806**	.732**	.231				
No of grains / main spike (x6)	Arish	.227	.244	.353	-.461	-.084			
	Rafah	-.121	.238	.244	.049	-.013			
1000 grain weight (x7)	Arish	-.424	-.376	-.349	.944**	.011	-.588*		
	Rafah	-.146	-.376	-.347	.181	.011	-.490		
Grain yield / plant (x8)	Arish	-.146	-.144	.013	.677*	.234	-.019	.693*	
	Rafah	-.105	-.043	.020	.247	.180	.418	.557*	
Biological yield / plant (x9)	Arish	-.295	-.366	-.264	.490	-.019	.110	.485	.815**
	Rafah	.046	.038	.058	.226	.312	.350	.572*	.974**

* and ** ; denote significant at 0.05 and 0.01 levels of probability, respectively.

Table 4. Components (direct and joint effects) in percentage of contribution, under Arish location

Source of variation	CD	RI%	Total contribution %
No. of spikes/plant (X_1)	0.05	1.85	12.19
No. of grains/main spike (X_2)	0.12	4.43	13.33
1000-grain weight (X_3)	0.80	29.52	50.73
Biological yield/plant (X_4)	0.21	7.75	17.53
(X_1) x (X_2)	0.07	2.58	-
(X_1) x (X_3)	-0.39	14.39	-
(X_1) x (X_4)	-0.10	3.69	-
(X_2) x (X_3)	-0.37	13.65	-
(X_2) x (X_4)	0.04	1.48	-
(X_3) x (X_4)	0.39	14.39	-
RESIDUAL	0.17	6.27	-
Total	1.00	100	93.78

CD : Coefficient of determination, RI% : Relative importance

Table 5. Components (direct and joint effects) in percentage of contribution, under Rafah location

Source of variation	CD	RI%	Total contribution%
No. of spikes/plant (X_1)	0.001	0.035	0.421
No. of spikelets/spike (X_2)	0.035	1.23	1.406
No. of grains/main spike (X_3)	0.838	29.49	45.495
1000-grain weight (X_4)	1.016	35.75	51.86
(X_1) x (X_2)	-0.002	0.070	-
(X_1) x (X_3)	-0.002	0.070	-
(X_1) x (X_4)	-0.008	0.281	-
(X_2) x (X_3)	-0.004	0.141	-
(X_2) x (X_4)	0.004	0.141	-
(X_3) x (X_4)	-0.904	31.81	-
RESIDUAL	0.028	0.985	-
Total	1.00	100.00	99.18

Considering the total contribution (direct and indirect), the results indicated that characters responsible for variation in plant yield in order of importance were number of spikes/plant (12.19%), No.of grains / spike (13.33%), 1000 grain weight (50.73%) and biological yield (17.53%) under Arish conditions. Nearly such relations to yield was previously detected in bread wheat by many authors (**Uddin *et al* 1997; Narwal *et al* 1999; Tammam *et al* 2000** and **Khattab *et al* 2001**), who indicated that bread wheat could be improved by straight selecting more number and heavier grains per spike. From the above results it is noticed that 1000-grain weight followed by biological yield /plant are considered the important selection criteria for isolating high yielding wheat genotypes under drought stress environments.

Under Rafah location the main sources of plant yield variation in order of importance were the direct effect of 1000-grain weight (35.75%) and its joint effect with under of grains/main spikes (31.81%) followed by the direct effect of number of grains/main spike (29.49%) and number of spikelets/spike (1.23%), while the direct effect of number of spikes/plant and its joint effects with other traits were negligible in magnitudes. The total contributions of these four traits was 99.01 %, while the residual effects was 0.99% **(Table 5)**. Under Rafah drought stress**;** the results of path coefficient analysis using phenotypic correlation**s** showed that the positive direct effects on grain yield / plant as relative importance in descending order are 1000 grain weight (51.86%), number of grains / spike (45.5%), Number of spikelets / spike (1.41%) while, remainder character was negligible. The indirect effect of 1000 grain weight *via* number of grains / spike was highly negative and quite important **(Table 5)**. These results indicated that the 1000-grain weight and number of grains/main spike are considered as main selection criteria for improving grain yield of wheat under Rafah conditions

In general, path coefficient analysis revealed that three variable indices including, 1000grain weight, biological yield, and number of grains / spike were the major contributors to grain yield under stress environments. **Narwal *et al* (1999), Dencic *et al* (2000),** and **Krishnawat *et al* (2000),** used path analysis in wheat under stress conditions and found similar conclusions.

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